Review of "Evaluation of four years continuous δ^{13}C(CO$_2$) data using a running Keeling approach" by S. N. Vardag, S. Hammer and I. Levin

General:

The manuscript deals with a four year combined record of δ^{13}C(CO$_2$) and CO$_2$ from Heidelberg in Germany. An of running Keeling plot approach has been applied in order to estimate the source signatures from the data. The approach including their set criteria were tested using a STILT model dataset representing the Heidelberg conditions as good as possible. The agreement between the known source signature in these modelled dataset and those retrieved from it using their running Keeling approach is surprisingly well. The application of their approach to the four years observed dataset yields a clear seasonality of the retrieved source signature between quite well defined limits using a 100 hours smoothing filter. Then they discussed the shortcomings of the method to disentangle the different unknowns, namely the fossil fuel share and its isotope composition as well as the isotope signature of biosphere source. They conclude that it is only possible to retrieve robust results under quite strict conditions, i.e. (i) a monotonous CO$_2$ increase of at least five ppm over a five hours interval and (ii) an uncertainty of below two permil for the source signature. This restricts their derived source signature dataset by 85%, which is very substantial, which is somewhat a disadvantage. Furthermore, they nicely document that the biosphere source signal can only reliably be estimated during summer. The fossil fuel source signature is in contrast only reliable during winter, when only δ^{13}C(CO$_2$) and CO$_2$ measurements are available.

I really enjoyed reading this manuscript and I suggest accepting it with only minor revisions.

Detailed comments:

Abstract:

L4: …opening the door to the quantification of CO$_2$ shares … or opening the door to quantify CO$_2$ shares …

L8: Disentangling this seasonal source signature into shares of source components is, however, ….

L13: …, such as D14C(CO2) or oxygen/carbon dioxide concentration ratios.

Main text

P2, L6-7: style, two times insight into ….reformulate one

P2, L32-33: eq. 2 and 3 are equivalent, therefore the about equal has to be changed to an equal sign in eq. 3.

P3, L10ff and L23ff is referring to the same topic, namely what kind of regression analyses should be used. These two parts should be combined. I personally would move the second part up.

P3, L 20f: This statement is two strict and has not been mentioned like this by Miller and Tans (2003). Otherwise, the comparison between regression filtered and STILT filtered source estimates would not be as good since most of the time simultaneous occurring sinks and sources are present.

P3, L25: What is WTLS? Is it the same as geometric mean regression (GMR) as discussed in Zobitz?

P4, L1: occurring

P4, L4: this approach leads to a strong auto-correlation of the source signature values.

P4, L5: maybe reformulate to something like: We choose five hours as a compromise between maximal number of data points and source mix constancy.

P4, L21: …as a decrease would be due …(delete of)

P4, L19ff: Why do you not apply a simple r2 criteria? Your criteria yield a significant reduction of data and corresponds to r2 larger than 0.9. What is the benefit of using your criteria of source signal uncertainty? R2 would also be independent on the regression method applied, the retrieved slopes and intercepts not. Maybe the errors are again independent, I have not checked it.

Section 2.3: (structure)

For the reader it would better to improve the visibility of the actual criteria in use: maybe with (i) … (ii)

P5, L11: …are 0-2‰ more enriched than the "filtered" source signatures (blue) as expected from our criteria.

P5, L16: …Keeling method and the used filter criteria on the model…

P5, L26: about instead of ca.?

P6, L12f: this finding is in excellent agreement with a previous source seasonality estimate by Sturm et al, which should be mentioned

Sturm, P., M. Leuenberger, F.L. Valentino, B. Lehmann, and B. Ihly, Measurements of CO2, its stable isotopes, O-2/N-2, and Rn-222 at Bern, Switzerland, *Atmospheric Chemistry and Physics*, *6*, 1991-2004, 2006.

P6, L27 delete sub-title 4.2.1

P7, L17: maybe it is better to use whether instead of if

P7, L24: …the mean measured isotope signature.

P7, L25: delete significantly

P8, L29 and 33: Why are the values different (1.5‰ and 1‰)?

P9, L2: Assuming constant isotopic end members over the course of one year, we would be able….

P9, L6: ….to the change in the fraction of respiration…

P9, L6: is it correct to say that in principle photosynthesis would also lead to an isotopic change but since you are analysing only positive CO2 gradients, i.e. CO2 release, you restricted it to respiration only. You might state this explicitly.

P9, L14: …into the fuel CO2 share.

P9, L17: ..there is a need of either …at the sources.

P9, L15ff (4.2.5): Nothing is said about the possibility to use oxygen measurement. A clear distinction between biospheric and fossil fuel sources can be calculated based on the different oxidation ratios for these two sources. Furthermore, calibrated CO/CO2 measurements are helpful as well as already documented in various studies.

P9, L27: ..aiming at an improved quantitative …

P9, L29: …and CO2 records for a potential partitioning of source contributions.

P9, L29f: this last sentence is not clear, please reformulate or delete it.

P10, L26: ditto as P8, L29 and L33.

Appendix A:

P11, L3: …air parcel originated from.

P11, eq. A1: still not clear to me why one has to use absolute concentration values. It leads to different delta values.

P18, Fig1c: The lengths of the red and green arrows is not the same since one has to balance CO2 and not 1/CO2. However, it might be not visible

P18, Caption: … or wind direction change (transportation)

P18; Caption, line 3: what do you mean with correct isotope signature, it is still a mixture and it has not been split up yet.

P20, It would be worthwhile to have the CO2 changes along with these graphs (at least for b and c.

P21: high values in 2011? Correct or artefact due to calibration issues?

P21: It would be nice to add the modelled curve for the year 2012.

P22: Why don't you use the radiocarbon that you have available and base your fossil fuel on inventory estimates?

P23: are the lower and upper 5% important? Have you used this filtering?